

**TRAINING & QUALIFICATIONS  
PROGRAM OFFICE**



**CONTAMINATION, HIGH CONTAMINATION and  
AIRBORNE RADIOACTIVITY TRAINING  
(RWT300)  
STUDY GUIDE**

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## ***Introduction***

This unit is designed to inform the worker of sources of radioactive contamination and methods to control its unwanted spread. This module provides personnel performing work within a Contaminated Area, High Contaminated Area or Airborne Radioactivity Area with the BNL site-wide core knowledge and skills needed to work safely while minimizing the spread of radioactive contamination. Additional department specific training may be necessary in order to meet access requirements for areas with unique contamination control concerns. Check with your Facility Support Representative before accessing these areas for the first time. In addition "Respiratory Protection" training, medical evaluation and respiratory fit testing are required prior to receiving authorization to wear respiratory protection equipment.

## ***Review of Terms***

A review of some commonly used radiological terms may help you better understand the concepts of radioactive contamination control.

### **IONIZING RADIATION**

Ionizing radiation is energy, with sufficient strength to cause the formation of ions, when interacting directly or indirectly with atoms.

### **RADIOACTIVE MATERIAL**

Radioactive material is the physical substance that contains radioactive atoms. Radioactive material is measured in units representing the number of radioactive atoms that give off their radiation (decay) in one minute, referred to as "Disintegrations Per Minute" or DPM. Radiation energy is emitted from radioactive material. Even when radioactive material is properly contained, it emits radiation that can penetrate the container and present an external radiation dose hazard.

### **DISPERSIBLE RADIOACTIVE MATERIAL**

Radioactive material in a form that can easily be spread, such as liquid, powder, or gas, is called dispersible radioactive material. Dispersible radioactive material typically exists as

sources used in performing scientific research. Care must be taken when handling dispersible radioactive material to ensure materials are not inadvertently spread to clean areas.

### **RADIOACTIVE CONTAMINATION**

Radioactive contamination is dispersible radioactive material in places where it is not desired. When quantifying radioactive contamination, we express the amount of removable radioactive material present on a surface area of  $100 \text{ cm}^2$ . The unit DPM/ $100\text{cm}^2$  is the standard unit used to express removable surface contamination. This measurement reflects the amount of contamination that would be removed from a surface area of  $100 \text{ cm}^2$  if you brushed up against it.

### **AIRBORNE RADIOACTIVITY**

Airborne radioactivity is simply radioactive contamination suspended in air. When measuring airborne radioactivity we are concerned with the amount of radioactivity suspended within the air that might be inhaled. Airborne radioactivity is measured in units representing the amount of radioactivity ( $\mu\text{Ci}$ ) suspended in a specified volume of air ( $\text{cm}^3$ ). The unit of  $\mu\text{Ci}/\text{cm}^3$  is the standard unit used to express a quantity of airborne radioactivity.

## ***Define a Contamination, High Contamination and Airborne Radioactivity Area.***

Radiological postings are used to alert personnel of various radiological hazards. For the purpose of radioactive contamination control we utilize three (3) different postings.

### **CONTAMINATION AREA**

If removable radioactive contamination exceeds:

1,000 dpm/100 cm<sup>2</sup> **beta-gamma** contamination

or

20 dpm/100 cm<sup>2</sup> **alpha** emitting contamination



### **HIGH CONTAMINATION AREA**

If removable contamination exceeds 100 times the Contamination Area levels:

100,000 dpm/100 cm<sup>2</sup> beta-gamma contamination

or

2,000 dpm/100 cm<sup>2</sup> alpha emitting contamination



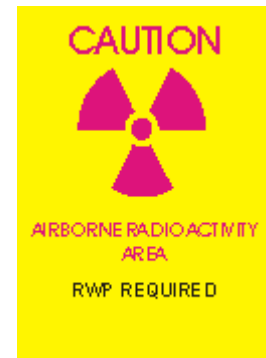
### **AIRBORNE RADIOACTIVITY AREA**

If airborne radioactivity concentration exceeds:

Individual may be exposed to 12 DAC-Hours in a week

or

Individual may be exposed to 100% of a DAC at any time



## ***Define the terms Annual Limit on Intake (ALI) and Derived Air Concentration (DAC).***

The effects from the potential uptake of radioactive material into the body are a primary concern regarding control of radioactive contamination. When evaluating an individual's total radiation dose, both external and internal exposure must be considered. This concept is called the Total Effective Dose Equivalent (TEDE) and is the summation of external dose registered on an individual's thermal luminescent dosimeter and the committed effective dose equivalent from internally deposited radioactive materials.

### **ANNUAL LIMIT on INTAKE**

In cases where a radioactive material accumulates in a specific organ (such as radioactive iodine in the thyroid) the organ dose is called a Committed Dose Equivalent (CDE) and the associated limit is 50 rem. By applying a "Weighting Factor" the CDE can be used to evaluate the dose contribution to the Whole Body. Once applied, the CDE is considered the Committed Effective Dose Equivalent (CEDE) to the Whole Body with a limit of 5 rem. The Annual Limit on Intake (ALI) is the quantity (amount) of a particular radionuclide, which if taken into the body, would result in receiving either a CDE of 50 rem to a specific organ or a CEDE of 5 rem to the whole body.

### **DERIVED AIR CONCENTRATION**

The Derived Air Concentration (DAC) is the airborne radioactivity level that, if breathed by a worker continuously for a work year (40 hours per week over 50 weeks), would result in depositing an amount of radioactive material inside the body equal to the Annual Limit on Intake. The DAC is based on the ALI and is derived by dividing the ALI by the volume of air a person would breathe in an occupational year (40 hours per week for 50 weeks).

Breathing this concentration of radioactive material for 2,000 hours would result in a CEDE of 5,000 mrem. If breathing this air for 2,000 hours results in 5,000 mrem, it can also be established that for each hour breathed, an individual could expect to receive a dose of 2.5 mrem.

## ***Define fixed, removable, soil and airborne radioactive contamination.***

### **FIXED CONTAMINATION**

Fixed contamination is contamination that cannot be readily removed from surfaces by casual contact, wiping, brushing, or washing. Fixed radioactive contamination does not pose a threat of being spread unless distributed by buffing, grinding, or using volatile cleaning liquids. Over time, fixed contamination may weep, leach, or otherwise become loose or transferable. Although it is not easily spread, at high enough levels it can pose a beta or gamma external exposure to the skin or to the lens of the eye.

### **REMOVABLE CONTAMINATION**

Removable contamination is contamination that can readily be removed from surfaces by casual contact, wiping, brushing, or washing. Air movement across removable/transferable contamination could cause airborne contamination. Loose contamination can be spread very easily. Once control is lost, an individual can "unknowingly" contaminate clean areas throughout the facility, personal vehicles, and private homes.

### **SOIL CONTAMINATION**

Soil contamination is radioactivity mixed within media (e.g. soil) at levels exceeding natural background. Soil contamination may exist at Brookhaven National Laboratory in areas that have been designated for clean up or have underground radioactive material. Contamination in these areas may be well below the levels required for Contamination Area posting, but require marking to prevent events involving spreading contamination. In the event soil contamination exceeds the limits for Contamination Area, it will be posted as such and appropriate access-control measures will apply.

### **AIRBORNE RADIOACTIVITY**

Airborne radioactivity is contamination, in any chemical or physical form, that is dissolved, mixed, vaporized, suspended, or otherwise entrained in air.

## ***Identify methods used to control radioactive contamination.***

Control of radioactive contamination can be achieved by applying sound administrative and engineering controls, utilizing the Radiological Work Permit process and employing good radiological work practices.

### **PREVENTIVE MAINTENANCE AND GOOD HOUSEKEEPING**

Preventive methods of controlling radioactive contamination include identifying and repairing leaks in radioactive fluid systems or components before they become a serious problem. A sound preventive maintenance program can prevent many radioactive material releases due to equipment failure. "Good Housekeeping" is the prime factor in an effective contamination control program. If while working within a facility you encounter a leaking valve or equipment in need of repair, report it to your supervisor so that maintenance can be performed before the problem becomes a major contamination concern. Each individual must be dedicated to keeping their work area free of debris and unnecessary tools or equipment to help control the spread of contamination.

### **PRE-STAGING WORK AREAS**

Another method to prevent the spread of contamination is to designate "staging areas" to prepare tools and equipment before using them with a Contamination Area. Cover piping and equipment adjacent to a work area to prevent dripping or dispersion of contamination onto clean(er) areas. Cover or tape tools or equipment used during the job to minimize the need for decontamination after the job (i.e. taping up a screwdriver before use).

### **HEPA VENTILATION SYSTEM**

Buildings that are "Engineered" for contamination control have ventilation systems designed to maintain airflow from areas of least contamination to areas of greatest contamination (e.g., clean to contaminated to highly contaminated areas). It is very important not to modify ventilation systems within areas that have a potential for contamination. Ventilation systems used in areas containing contamination are designed to maintain a slight negative pressure within



the building or room so that any leakage is exhausted through a High Efficiency Particulate Activity (HEPA) filter rather than directly to the environment.

## **CONTAINMENT / CONFINEMENT**

Total containment of radioactive contamination can be achieved by constructing an enclosure designed to contain all particulates, liquids, and gases that will be generated by the activity. Using large vessels, cells, glove bags or glove boxes, and tents or huts can restrict the contamination to small areas. Other useful containment and confinement techniques include using hoses, tubing or sheathing, drip pans, and catch basins to confine and collect contamination. These will also reduce the cost and time necessary for clean up and disposal of waste.

## **DECONTAMINATION**

If removable contamination is discovered, the area may be decontaminated to reduce the potential hazard. In some situations, this is not always possible or desired. Economical and/or radiological conditions may need to be taken into account, since the cost of labor and the dose received by personnel may outweigh the hazards of the contamination present. Also, Radioactive Material Areas designated for storage can provide material accountability and control while preventing spread of contamination.

## **RADIOLOGICAL WORK PERMITS**

The Radiological Work Permit (RWP) process is an extension of the BNL Standards Based Management System (SBMS) Work Planning and Experimental Review processes. During the initial review process, if it is determined that the work will involve entering a Contamination, High Contamination, or Airborne Radioactivity Area, then work planning must include a Radiological Work Permit. The RWP process promotes communication between Radiological Control personnel

Brookhaven National Laboratory				RWP# : 938-001	
RADIOLOGICAL WORK PERMIT				Start Date: Today	
				End Date: Today	
Shaded areas to be completed by requestor				Revised End Date:	
1. Initiator: Job Supervisor		2. RWP #: 99999		3. Phone: 9999	
4. Bag: 129-A					
5. Job Location: Upper level, Building 938					
6. Job Description (attach sheets as needed): Check the box of the activity to be performed on the job with the RWP. It is already checked.					
6a. Work Begins: 0800		6b. Work Ends: 1600			
7. Radiological Other Concerns: (check boxes if conditions have resulted in abnormal contamination and/or dose accumulation in the area)					
8. Signature of Initiator: Job Supervisor					
9. Conditions that will void the RWP: (Changes in the scope of the activity, changes in the design, conditions requiring modification of the RWP)					
10. Job Review:		11. Estimated Doses:		12. Attachments:	
<input type="checkbox"/> Pre-Work Review <input checked="" type="checkbox"/> Pre-Work Review <input type="checkbox"/> Summary/Control <input type="checkbox"/> Other <input type="checkbox"/> Not Applicable		<input type="checkbox"/> Pre-Work <input type="checkbox"/> Pre-Work <input type="checkbox"/> Highest Individual: _____ mSv <input type="checkbox"/> Collective: _____ mSv <input checked="" type="checkbox"/> Not Applicable		<input checked="" type="checkbox"/> Radiological Review Form <input type="checkbox"/> Radiological Document <input type="checkbox"/> Other <input type="checkbox"/> Not Applicable	
13. Work Controls:		14. Protective Clothing:		15. Dosemeters:	
<input type="checkbox"/> Respiratory Protection <input type="checkbox"/> Containment <input type="checkbox"/> Isolation (see Section 11) <input type="checkbox"/> Decontamination <input type="checkbox"/> Other <input checked="" type="checkbox"/> Not Applicable		<input checked="" type="checkbox"/> Gown (Robe) <input type="checkbox"/> Shoe Cover <input type="checkbox"/> Goggles (Goggles) <input type="checkbox"/> Goggles <input type="checkbox"/> Head Cover <input type="checkbox"/> Other <input checked="" type="checkbox"/> Not Applicable		<input type="checkbox"/> Self-Reading Dosemeter <input type="checkbox"/> Area <input type="checkbox"/> Warning/Overdose <input type="checkbox"/> Filter Dosemeter <input type="checkbox"/> Not Applicable	
16. Checklist Instructions:					
<input type="checkbox"/> Whole Body Count <input type="checkbox"/> Urine Sample (Bioassay) <input type="checkbox"/> Contamination Check <input type="checkbox"/> Personal <input type="checkbox"/> Equipment <input type="checkbox"/> Other <input checked="" type="checkbox"/> Not Applicable					
17. Special Instructions: (Hold Points, special dose limits, etc.): - See Low Dose Radiological Work Permit (RWP) at 938-001 - See High Dose Radiological Work Permit (RWP) at 938-002					
18. Signature Approver:		Signature		Date	
F. S. Representative		Radiological Control		99999	
Other (Specify):					
19. Close-Out Signature:		Signature		Date	
F. S. Representative					

When complete the RWP provides the work group with details necessary to reduce or prevent contamination spread throughout the activity. It is very important to review all the information contained on a Radiation Work Permit prior to beginning work within a contaminated area. Each individual must document that they have reviewed the RWP prior to entering any area.

[illegible]

If the Radiological Work Permit requires dose tracking using supplemental dosimetry (pencil type or digital dosimeter), individuals acknowledge that they have read, understand, and will comply with the RWP on an RWP Access Control Log. Each individual must enter their name and life number and sign and date the form and upon entry write the time and indicated dose on their dosimetry. After completing the activity, or when leaving the area, the

[illegible]

10

## **PROTECTIVE CLOTHING (PCs)**

If administrative and engineering controls cannot provide adequate control for radioactive contamination, then protective clothing (PCs) should be used. Required protective clothing is prescribed on the Radiological Work Permit and is selected based on the contamination level in the work area and the anticipated work activity.

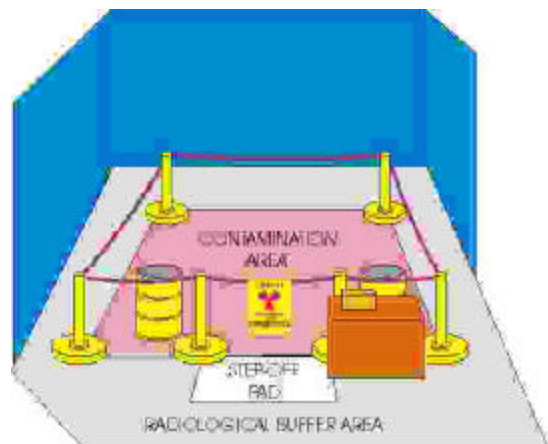
## **STEP-OFF PADS**

Step-off pads are used as a transition point from a "Contamination Area" to a non-contaminated area. Contamination monitoring equipment is located at the step-off-pad. Personnel contamination monitoring must be performed while transiting from the contaminated area to the non-contaminated area to verify no contamination is present on skin, clothing, or equipment before leaving the posted Contamination Area. There are several possible configurations for using step-off pads.

### **Single Step-Off Pad – Radiological Buffer Area (RBA)**

A Radiological Buffer Area (RBA) is established around a Contamination Area in order to minimize the potential spread of radioactive contamination into Controlled Area. RBAs are checked routinely for contamination. Any indication of contamination within the RBA warns that the Contamination Area is inadvertently migrating beyond the posted Contamination Area boundaries.

Single step-off pads are located outside of the Contamination Area, but within RBA boundaries. The pads are considered free of radioactive contamination. Labeled containers are located inside of the Contamination Area boundary for the collection of protective clothing, used respiratory protection equipment, and debris. Separate containers will be available for "Waste" and "Used PC's." It is important to segregate waste from reusable items in order to minimize radioactive wastes.



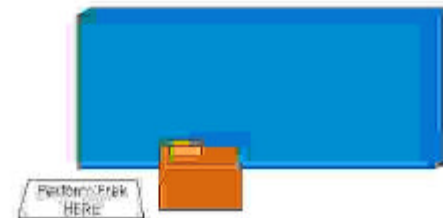
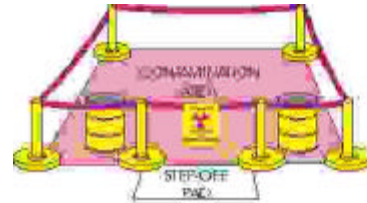
### Single Step-Off Pad – NO Radiological Buffer Area

When the potential for radioactive contamination migration is unlikely (such as a Contamination Area within a sealed room) the Step-off-Pad itself can adequately serve as the Radiological Buffer Area.



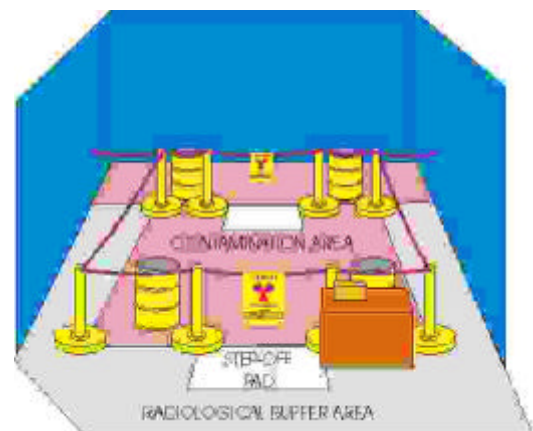
### Remote Step-Off-Pad

When background radiation is too high, personnel contamination monitoring equipment cannot be used to release items from a Contaminated Area. Should background levels prohibit setting up a monitoring station, the Step-Off Pad (SOP) may be positioned remotely at a point where background levels are low enough to perform personnel monitoring. When using remote step-off pads, care must be exercised to minimize the chance of spreading contamination from the point of exit to the remote area. Hands and feet should be surveyed immediately after arriving at the remote step-off pad to check for the spread of contamination during transit.



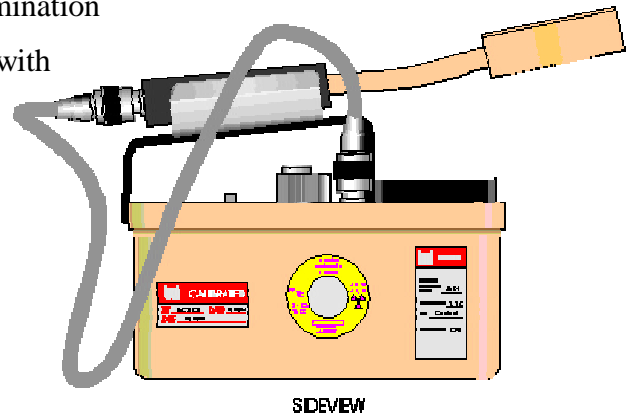
### Multiple Step-Off-Pads

Multiple SOPs allow personnel dressed in multiple layers of protective clothing to remove the outer, highly contaminated, clothing while minimizing the chance of spreading contamination to clean areas. The innermost SOP is used to remove the outermost PCs. Highly contaminated materials should be bagged separately. The outermost SOP is used to remove the innermost protective clothing. Personnel monitoring equipment will be located outside of the outermost SOP. When using multiple SOP, SOP within the outermost Contamination Area boundary must be considered contaminated.



## ***Perform pre-operational checks of a contamination monitoring instrument.***

The primary instrument for personnel contamination monitoring at step-off-pads is the Ludlum Model 3 with pancake style probe. This meter and probe combination is used for beta/gamma contamination monitoring. In the event alpha contamination is present, Facility Support Technicians will provide additional guidance and assistance in performing personnel contamination monitoring.



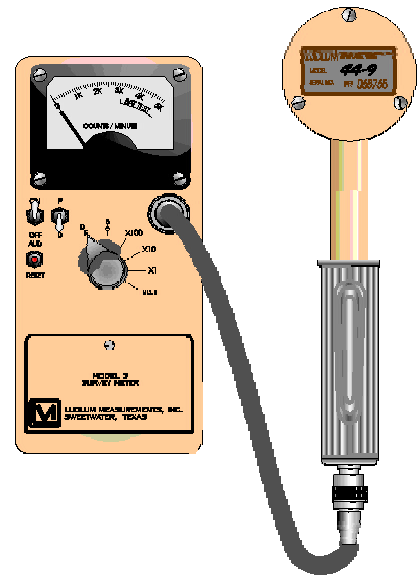
### **METER INTERPRETATION**

The Ludlum Model 3 has a range from 0 – 500K counts per minute. The detector probe is only 10% efficient, so each “COUNT PER MINUTE” (CPM) that it detects represents 10 “DISINTEGRATIONS PER MINUTE” (DPM). Since BNL’s limit for contamination is 1,000 an indication of 100 CPM on the Ludlum Model 3 represents the contamination limit of 1,000 DPM.

The meter face on the Ludlum Model 3 ranges from 0 to 5K COUNTS/MINUTE. Using this range, it would be extremely difficult to distinguish count rates as low as 100 CPM. Each small black line represents 100 CPM. Utilizing the detector’s multiplier switch, the Ludlum Model 3 meter indication can be weighted by a factor of X0.1, X1, X10, X100. When interpreting the meter indication, one must first obtain the indicated value and then apply the multiplier switch setting to obtain the actual indication.

For example, with the Ludlum Model 3 meter indicating 3K and the instrument selector switch positioned on the X0.1 multiplier, the actual indication would be:

$$(3K \text{ CPM}) \times (0.1) = 300 \text{ CPM}$$

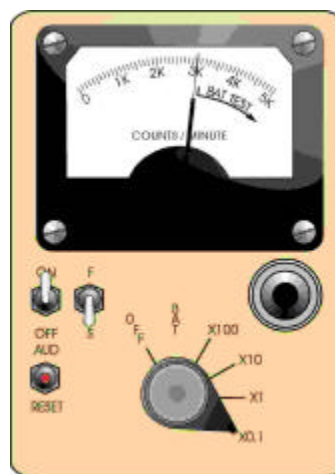


Practice interpreting the Ludlum Model 3 meter. (answers on the bottom of this page)

**A**



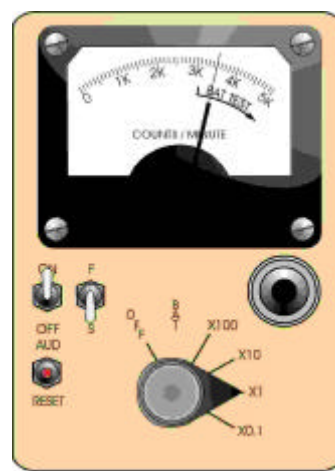
**B**



**C**



**D**



**E**



**F**



(Answers: A – 1500 CPM; B – 300 CPM; C – 50 CPM; D – 3500 CPM; E – 170 CPM; F – 3000 CPM)

## **PRE-OPERATIONAL CHECKS**

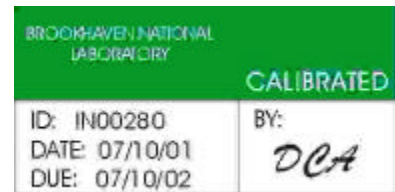
Pre-operational checks must be performed prior to entering a contamination area to ensure the instrument is available for use upon exiting the area. Pre-operational checks include a visual inspection, calibration check, battery check and a source response check. The source response check is only necessary to perform once each day prior to its first use.

### **Visual Inspection**

A visual inspection should be performed prior to entry into a contaminated area in order to ensure the frisker is available and functional for your exit monitoring. Inspect the meter face for any damage, such as a cracked or missing window. Check the cable that attaches the probe to instrument to ensure that it is in good order. Check the probe face for integrity of the mica window to ensure it is not punctured or otherwise damaged. Make sure all knobs and switches are functioning properly. Check the instrument case for any dents or breaks. If for any reason the instrument does not appear to be in good physical condition, label the instrument in a manner that clearly indicates it should not be used, such as "OUT of ORDER" or "DO NOT USE." Notify the Facility Support Technician that your frisker requires repair.

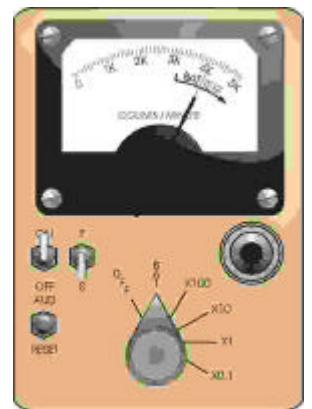
### **Calibration Check**

On the side of each frisker is a small BNL Calibration sticker. Check that the posted "Calibration Due Date" has not expired. The calibration sticker must not only be present, but must also be current and legible. A damaged calibration sticker or one that cannot be clearly interpreted voids the calibration of the instrument. If the instrument is beyond its calibration due date or the calibration sticker is missing or illegible label the inoperable instrument and select another instrument. Notify the Facility Support Technician that your frisker requires calibration.



### **Battery Check**

To perform a battery check, turn selector switch to the "BAT" position and watch the needle response on the meter face. If the needle falls "short" of the "BAT TEST" area on the meter face, label the inoperable instrument and select another instrument. Contact an FS Technician to replace the batteries or provide a new frisker. It is a good practice to perform this check before each entry to ensure the instrument will work properly upon exit.



## ***Perform a source response check***

Personnel contamination monitoring instruments must be source response checked at least once each day, prior to their first use. Most instruments that are used for personnel contamination monitoring are calibrated for use only on the most sensitive range (X0.1). These instruments will have a sticker indicating that the instrument was calibrated only for a specific range of detection. **DO NOT USE** a contamination monitoring instrument beyond the specific range that it was calibrated for.

SOURCE CHECKED			
INSTRUMENT			
SERIAL NO.			
DATE			
CAL.	RANGE	DATE	TIME
1		17	
2		18	
3		19	
4		20	
5		21	
6		22	
7		23	
8		24	
9		25	
10		26	
11		27	
12		28	
13		29	
14		30	
15		31	
16			

Prior to using a contamination monitoring instrument check either the "Daily Source Response Check" tag attached to the instrument or the response check log sheet to verify a check has been performed. If indication is present indicating that a source response check has been performed previously that day, there is no need to perform this check. If the tag attached to the instrument or the response check log sheet, does not indicate that a daily response check has been performed, then the instrument **MUST BE RESPONSE CHECKED** prior to use. It is important to ensure that the response check has been successfully completed prior to entering a contaminated area.

To perform this check, turn the instrument selector switch to the lowest scale (X0.1). Allow the instrument to stabilize for approximately 15 seconds and observe the background reading on the meter. Note the expected check source response posted on the side of the instrument next to the small button source. Place the probe face directly over the button source on the side of the instrument. Allow the instrument to respond for approximately 15 to 20 seconds. If the needle falls within  $\pm 20\%$  of the expected check source response, the instrument source check is satisfactory. Document completion of the daily source response check by placing your initials in the block representing the current day of the month. If the instrument is not responding properly, label the inoperable instrument and select another instrument and contact an FS Technician. **DO NOT USE** an instrument that does not respond as expected.





TOTAL, is the cumulative dose obtained while within the work area and is derived by subtracting the value of the dosimeter reading upon entry from the dosimeter reading upon exit.

Each time you enter and leave the area affected by the Radiological Work Permit, you must sign-in and sign out of the Access Control Log. Exceptions are allowed when individuals are making multiple entries to the same area during the same day. In this case, it is only required that the individual sign-in upon initial entry and sign out upon final exit each day.

### **WORKING WITHIN CONTAMINATION AREAS**

Workers must abide by the requirements of the Radiological Work Permit issued for their job. While working in a contaminated area, avoid practices that promote the spread of contamination, such as dragging your feet across surfaces, sweeping or brushing surfaces, or using compressed air. If air hoses or electrical supply lines must breach the Contamination Area boundary, ensure they are securely fastened to the floor or an immovable object to avoid inadvertently spreading contamination by moving the lines in and out of the affected area. Do not touch any exposed skin, such as your face. To minimize the potential for getting radioactive material inside your body, do not enter contamination areas with open cuts or abrasions. Immediately leave the contaminated area if you cut yourself or open a wound. Do not smoke, eat, drink, or chew while within contaminated areas. If your protective clothing will not protect you against a spill of radioactive contamination, such as a liquid spill when using cloth PCs, immediately leave the area and contact the Facility Support Technician for assistance. DO NOT attempt to stop the spill unless you can do so without jeopardizing the integrity of your protective clothing.

### **EXITING A CONTAMINATION AREA**

When exiting a contamination area, approach the step-off pad, but do not cross the Contamination Area barrier rope without first removing your protective clothing. Stay one or two feet away from the to minimize the chance of contamination falling off onto the clean Step-Off Pad. All protective clothing must be removed while within the Contamination Area and personnel contamination monitoring must be performed before exiting the Step-Off Pad.

All equipment and materials must be left behind within the Contaminated Area until a qualified Facility Support Technician surveys them to ensure they are not contaminated.

## Select, Don, and Remove Protective Clothing.

Before entering a contaminated area, workers must select the appropriate protective clothing based upon the requirements specified within the Radiological Work Permit. The sample Radiological Work Permit illustrated to the right identifies that double gloves, inner and outer booties, full coveralls, and a head cover are required for this job.

When selecting protective clothing, workers should ensure that they have selected the proper size clothing (such as coveralls, outer gloves, and outer rubber overshoes).

Before donning the protective clothing, all personal effects such as watches, rings, and chains should be removed. If desired, wedding rings may be left on, but should be taped to prevent damage to the PC's. Personal clothing should not be worn under protective clothing.

Instead, Departments provide “modesty garments” such as surgical scrubs or gym shorts and shirts.

Before donning, inspect all protective clothing for defects, such as rips, tears, holes, and degradation of seams, broken zippers, or missing buttons. Also, check for pinhole in gloves by trapping air and lightly squeezing the glove to check for deflation. **DO NOT** use damaged PC's. If defective PCs are identified, mark them DO NOT USE and set them aside for disposition by the Facility Support Technician.

### **DONNING PROTECTIVE CLOTHING**

The sequence for donning PCs listed below is designed to provide adequate protection from contamination and minimize the risk of a personal contamination event when attempting to remove the PC's. The sequence is as follows:

Brookhaven National Laboratory		RW/P#: 938-001	
RADIOLOGICAL WORK PERMIT		Start Date: Today	
		End Date: Today	
Shaded area to be completed by requestor		Revised End Date:	
1. Initiator: Job Supervisor		2. Life #: 99999	3. Phone: 9999 4. Bldg: 129-4
5. Job Location: Upper Level, Building 938			
6. Job Description (Attach sheets as needed): Check the door of the red fire alarm panel located on the East wall to ensure it is securely locked.			
6a. Work Begins: 08:00		6b. Work Ends: 16:30	
7. Historical/Other Concerns: Previous activities of this nature have resulted in personnel contamination and/or contamination of RWPA.			
8. Signature of Initiator: Job Supervisor			
9. Conditions that will void the RW/P: Changes in the scope of the activity, changes in radiological conditions requiring modification of the RW/P.			
10. Job Review: <input type="checkbox"/> Previous Review <input checked="" type="checkbox"/> Previous Review <input type="checkbox"/> ALARA Review <input type="checkbox"/> Summary Case <input type="checkbox"/> Other <input type="checkbox"/> Not Applicable	11. Estimated Doses: <input type="checkbox"/> Per Job <input type="checkbox"/> Per Entry Highest Individual _____ mrem Collective _____ mrem <input checked="" type="checkbox"/> Not Applicable	12. Attachments: <input checked="" type="checkbox"/> Radiological Survey Form <input type="checkbox"/> Technical Work Document <input type="checkbox"/> Other <input type="checkbox"/> Not Applicable	13. Training Requirements: <input checked="" type="checkbox"/> Radiology 1 (RW002) <input type="checkbox"/> High Radiation (RW400) <input checked="" type="checkbox"/> Contamination (RW300) <input type="checkbox"/> Biohazard/Decontamination (RW1500) <input type="checkbox"/> Activation (RW1200) <input type="checkbox"/> Other
14. Work Controls: <input type="checkbox"/> Facility Support Coverage <input type="checkbox"/> Interim <input type="checkbox"/> Contingency <input type="checkbox"/> Hold Points (See Section 17) <input type="checkbox"/> Antineutrino <input type="checkbox"/> Shielding <input type="checkbox"/> Other <input checked="" type="checkbox"/> Not Applicable	15. Protective Clothing: <input checked="" type="checkbox"/> Gloves (Double) <input type="checkbox"/> Shoe Covers <input checked="" type="checkbox"/> Booties (Outer Rubber) <input type="checkbox"/> Goggles <input type="checkbox"/> Red Imm Lab Coat <input type="checkbox"/> Respirator <input checked="" type="checkbox"/> Head Cover <input type="checkbox"/> Other <input type="checkbox"/> Not Applicable	16. Dosimetry: <input checked="" type="checkbox"/> TLD <input type="checkbox"/> Self-Reading Dosimeter <input type="checkbox"/> Pocket <input type="checkbox"/> Digital <input type="checkbox"/> Alarming Dosimeter <input type="checkbox"/> Finger Dosimetry <input type="checkbox"/> Not Applicable	17. Checkout Instructions: <input type="checkbox"/> Whole Body Count <input type="checkbox"/> Urine Sample (Bioassay) <input checked="" type="checkbox"/> Contamination Check <input type="checkbox"/> Equipment <input type="checkbox"/> Equipment Return <input type="checkbox"/> PCM-35 <input type="checkbox"/> Scale <input type="checkbox"/> Radi Job Survey <input type="checkbox"/> Not Applicable
18. Special Instructions: (Hold Points, special dose limits, etc.): - Use Low Dose Rate Working Area (LDRA) as much as possible. - Risk of materials leaving the RWPA.			
19. Signature Approvals: Signature F. S. Representative		Department Radiological Control	Life Number 99998
Other (Department Specific)			Date Today
20. Close-Out Signature: F. S. Representative			

1. Check to ensure your TLD is attached to your innermost garment.
2. Don the inner booties.
3. Don the coveralls, then tape the coverall legs to the inner booties. Tab the end of the tape to aid removal.
4. Next, don the outer rubber overshoes.
5. If supplemental dosimetry is required, place it in the pocket of the coveralls.
6. Don the inner protective gloves and tape them to the coverall sleeves. Cloth inner gloves may be worn, BUT are not considered protective gloves.
7. Don the outer protective gloves, BUT do not tape them to the coveralls.
8. Don respiratory protection if required by the RWP.
9. Don the head cover taping as necessary to keep it in place while working.

When exiting a contamination area, approach the step-off-pad, but do not cross the pad without removing PC's first. Stay a foot or two away from the pad so as to minimize the chance of contamination falling off into a clean area.

### **REMOVING PROTECTIVE CLOTHING**

As with donning, this sequence of removing protective clothing is not "cast in stone" but instead is based on years of experience. Removing protective clothing in the prescribed sequence will minimize the risk of personal contamination when attempting to exit the Contamination Area. Instructions for the correct sequence for removing protective clothing should be posted near the step-off pad. It is important that you stay back from the Contamination Area boundary while removing protective clothing to prevent spreading onto the clean Step-Off Pad. The sequence for removing protective clothing is as follows:

1. First, remove all exposed tape and dispose of it in the "Contaminated Trash."
2. Remove your rubber overshoes and place in the "Used PCs." Face away from the SOP while removing overshoes to prevent contamination from spreading onto the SOP.
3. Remove outer protective gloves and place them in the "Used PCs."
4. Remove the head cover and place it in the "Used PCs."
5. If worn, remove respiratory protection and place it in the "Used Respirators."
6. If used, remove supplemental dosimetry and place it on the edge of the SOP. Read the dosimeter before placing it on the SOP in case it gets damaged.

7. Remove tape from inner gloves and dispose of it in the "Contaminated Trash."
8. Remove coveralls and place in the "Used PCs."
9. Take down the barrier rope.
10. Remove inner booties one at a time, stepping unprotected foot onto SOP
11. Replace the barrier rope.
12. Remove inner gloves and dispose of it in the "Contaminated Trash."
13. Perform personal contamination monitoring before leaving the Step-Off Pad.

### ***Perform personnel contamination monitoring.***

A whole body contamination check must be performed prior to leaving the Contamination Area Step-Off Pad. The personal monitoring instrument should have been already set up with pre-operational checks completed and the instrument turned on. Before starting, observe the indicated background and verify it is less than 200 CPM. Also, verify that the instrument is on the X0.1 scale, the audible is on, and the instrument response is set to "SLOW".

#### **CONTAMINATION MONITORING PROCEDURE**

With the probe in its holder, survey your hands without picking up the probe. Hold the surface of your hand within ½ inch from the surface of the probe. Survey the entire surface of each hand, moving your hand across the surface of the probe at a rate of approximately 1 to 2 inches per second. If your hands are contaminated, **DO NOT PICK-UP THE PROBE.** Contact, or have someone else contact, the Facility Support Technician to assist you. If your hands are not contaminated, pick up the probe from its holder and begin frisking your whole body.

A survey of your entire body, if done correctly, should take several minutes. When frisking your head, pause for approximately 5 seconds in the area of your nose and mouth. Next, frisk your neck and shoulders. When frisking your arms, pause at each elbow, and then continue to frisk your chest, abdomen, back, hips, and the seat of your pants. Pause at each knee when frisking your legs. Continue with your shoe tops and bottoms. Finally, frisk your dosimetry before you pick it up. During the survey, it is very important to concentrate your efforts on locations that are most likely to become contaminated, such as hair and face, elbows, seat of your pants, pant leg bottoms (if personal clothing was worn), shoe tops and soles, and hands.

## ***Respond to indication of contamination on skin or clothing***

### **INCREASED AUDIBLE COUNT RATE**

Multiple "clicks" will occur randomly while performing a frisk. If while performing personal monitoring, you encounter multiple "clicks", move the probe back slightly so it is positioned over the area surveyed just before the noticeable increase. Hold the probe in that position for just a few seconds and allow the instrument to respond. If the rate of audible "clicks" decreases, continue with your survey. If the rate of audible "clicks" remains higher than normal observe the indication on the meter. If at any time the meter indicates greater than 100 counts/minute above background, contamination exists above the release limits and corrective actions are necessary.

### **Required Actions**

Do not panic if the personal monitor indicates greater than 100 counts/minute above background. Instead, it is important that you continue surveying the remainder of your body to identify whether additional areas of contamination are present. If while continuing to survey the remainder of your body, another person arrives or is present, have them go to a phone and contact the Facility Support Technician for assistance. If, after completing a whole body contamination survey, there is no one else available to assist, it will be necessary for you to leave the immediate area to obtain assistance. Knowing where the contamination is on your body, carefully go to the nearest phone and contact the Facility Support Technician. Attempt to control the spread of contamination by not allowing the affected area of the body to touch any other surface. If necessary, cover the affected area before touching a clean surface. If the contamination is on the bottom of your shoes remove them before leaving the Step-Off-Pad.

After contacting the Facility Support Technician remain near the telephone in case the Facility Support Technician needs to contact you for additional information.

### **PERSONNEL CONTAMINATION MONITORS (PCMs)**

In Contamination Areas where there are frequent entries of many people, a Personnel Contamination Monitor, commonly referred to as a PCM, may be present. This device performs a survey of your entire body in a fraction of the time required for the hand-help "frisker." When

available, these devices are typically located near the Step-Off Pad, within the Radiological Buffer Area. Personnel exiting the Contamination area typically survey only hands and feet, then proceed along a prescribed path from the Step-Off Pad to the PCM. The PCM completes the survey of the entire body. If contamination is detected, the PCM will alarm and inform the individual of the approximate location of the body that is contaminated.

If an alarm occurs while using a Personnel Contamination Monitor immediately contact a Facility Support Technician for assistance and follow the protocol at the monitoring station.

### ***Describe the normal methods for personnel decontamination.***

If a worker should become contaminated while in a contamination area, decontamination of the individual will only be done at the direction of Radiological Control Division personnel. Only QUALIFIED personnel are allowed to direct decontamination. It is important not to take it upon yourself to determine the need for or to perform personnel decontamination unless directed to do so.

There are several methods that can be used to remove contamination from an individual. Washing with luke warm (tepid) water and mild soap is used most often as the initial attempt to decontaminate. If the contamination is liquid, then initially it is removed from the skin with a blotting action, avoiding any wiping motion that may embed contamination into the skin.

Particulate type contamination may be removed using a tape press, waterless cleaners, vacuuming (but only with special vacuums), and sweating. Sweating is an effective method to remove contamination from the hands. It involves wearing rubber gloves with absorbent inner lining. As the individual's hands sweat, the contamination is transferred to the absorbent inner lining.

As with all methods of decontamination, **NO** abrasive methods will be used. In the event the "mild" decontamination methods fail to remove the contamination, alternative methods will be evaluated thoroughly by medical and/or professional personnel before any other additional attempts are performed.

## ***State the necessary actions to release material from a posted Contamination Area.***

Everything in a posted Contamination Area is considered contaminated with radioactive material. To remove something from a Contamination Area, the item must first be proven free of radioactive contamination, often referred to as “clean.” As with personnel exiting a Contamination Area, all tools and equipment must be surveyed for radioactive contamination prior to release from the area.

### **RELEASE CRITERIA**

A qualified Facility Support Technician must survey all the items leaving the posted Contamination Area. It is therefore very important that you plan your job well and take only those materials necessary to perform the work into the area.

If the Facility Support Technician surveying the item determines that the item is free of radioactive contamination, then the item can be immediately removed from the area. If radioactive contamination is found on the item, it must be properly packaged and labeled before it can be released from the area. Packaged items can be removed from the posted Contamination Area but cannot be opened unless they are within another posted Contamination Area.

All items removed from a posted Contamination Area for unrestricted use must be itemized on a Clean Item Log or Release Log, typically located at the area step-off-pad.

## ***Describe the methods used for decontamination of areas, tools, and equipment.***

Only qualified personnel may perform decontamination. Decontamination of areas, tools, and equipment, which must be performed under the direction of Radiological Control Division personnel.

In general, most low level contamination on tools or equipment can be removed by wiping with a damp cloth. For contamination on floors or large surface areas, decontamination is performed using a damp mop or water and a squeegee.

To minimize the spread of high levels of contamination to areas of lower levels, decontamination always begins at the area of lowest contamination and proceeds to the area of



greater contamination. If decontamination were to begin in the area of highest levels, residual radioactive contamination on gloves and protective clothing could be inadvertently transferred to areas of lower contamination levels. This technique can also be applied while performing work within a Contamination Area. If practical, plan your work so the activities in the lowest contamination levels within the area are performed first. That way, as the job progresses, residual contamination levels on gloves and protective clothing will not be higher than the contamination levels in the next work area.

### ***State the correct response to accidents, injuries, and emergencies.***

A spill of non-radioactive material looks exactly like that of a radioactive spill. It is important to treat as CONTAMINATED any uncontrolled release of material that may have the potential of being contaminated. Not taking spilled material seriously or ignoring indications of a possible spill has resulted in incidents of wide spread contamination.

### **ENCOUNTERING RADIOACTIVE LIQUID SPILLS**

In dealing with a radioactive liquid spill, it is important that you DO NOT manipulate valves to stop a radioactive liquid spill UNLESS you are personally qualified to operate the system involved. Shutting valves to stop liquid spills may appear to be the “common sense” approach, BUT unless you are fully aware of what effect manipulating the valve has on the system, serious unplanned consequences may develop.

Follow these steps if you find a radioactive spill in your area:

1. Notify everyone in the area of the spill.
2. Place your work in a safe condition.
3. Notify the Facility Support technician. If you cannot contact a technician, call 2222 or 911 and notify the BNL Emergency Response personnel.
4. Remain nearby to restrict access and brief response personnel when they arrive.

### **ENCOUNTERING EVACUATION ALARMS WHILE IN A CONTAMINATED AREA**

Emergencies always take priority over the normally required removal of PC and frisking. If you hear the building evacuation alarm and a drill has not been announced, you must assume it is a true emergency and that the danger may not be readily apparent to you. Immediately place

your work in a safe condition and evacuate the building without removing protective clothing or performing contamination monitoring.

### **ENCOUNTERING INJURIES IN A CONTAMINATED AREA**

A life-threatening injury will ALWAYS take priority over any radiological consideration. Medical treatment should NEVER be delayed unless the radiation is also life threatening to response personnel. If a life-threatening injury occurs within a contaminated area, controlling the spread of contamination becomes a secondary concern. The saving of a life WILL ALWAYS TAKE PRECEDENCE!

Immediately exit the area and call 2222 or 911 and advise the BNL Fire/Rescue Group of the injured person within a posted Contamination Area. Do not hesitate by removing protective clothing. Do not hesitate by performing personnel monitoring. Immediately proceed to the nearest method of communication and call for help. It cannot be stressed enough the importance of IMMEDIATE NOTIFICATION in the event that a life-threatening injury is encountered within a Contamination Area.

***Given a Radiological Work Permit and associated Radiological Survey Form, demonstrate the ability to interpret and utilize the information.***

In the Contamination, High Contamination, and Airborne Radioactivity classroom training each individual is given a Radiological Work Permit and Radiological Survey Form for a job that will be performed during the practical exercise. It is important that you review this information before taking a challenge examination because questions may contain information pertaining to the Radiological Work Permit and Survey Form.

<b>Brookhaven National Laboratory</b>		RWP#: <u>938-001</u>	
<b>RADIOLOGICAL WORK PERMIT</b>		Start Date: <u>Today</u>	
<input checked="" type="checkbox"/> Job Specific <input type="checkbox"/> General		End Date: <u>Today</u>	
Shaded area to be completed by requestor		Revised End Date: _____	
1. Initiator: <u>Job Supervisor</u>	2. Life #: <u>99999</u>	3. Phone: <u>9999</u>	4. Bldg: <u>129-A</u>
5. Job Location: <u>Upper Level, Building 938</u>			
6. Job Description (Attach sheets as needed): <u>Check the door of the red fire alarm panel located on the East wall to ensure it is securely locked</u>			
6a. Work Begins: <u>08:00</u>		6b. Work Ends: <u>16:30</u>	
7. Historical / Other Concerns: <u>Previous activities of this nature have resulted in personnel contamination and cross contamination of the RBA.</u>			
8. Signature of Initiator: <u>Job Supervisor</u>			
9. Conditions that will void the RWP: <u>Changes in the scope of the activity, changes in radiological conditions requiring modification of the RWP</u>			
10. Job Review:	11. Estimated Doses:	12. Attachments:	13. Training Requirements:
<input type="checkbox"/> Pre-Job Review <input checked="" type="checkbox"/> Pre-Job Briefing <input type="checkbox"/> ALARA Review <input type="checkbox"/> Summary / Closure <input type="checkbox"/> Other _____ <input type="checkbox"/> Not Applicable	<input type="checkbox"/> Per Job <input type="checkbox"/> Per Entry  Highest Individual: _____ mRem Collective: _____ mRem <input checked="" type="checkbox"/> Not Applicable	<input checked="" type="checkbox"/> Radiological Survey Form <input type="checkbox"/> Technical Work Document <input type="checkbox"/> Other _____ <input type="checkbox"/> Not Applicable	<input checked="" type="checkbox"/> RadWorker 1 (RW1002) <input type="checkbox"/> High Radiation (RW1400) <input checked="" type="checkbox"/> Contamination (RW1300) <input type="checkbox"/> Benchtop/Dispensable (RW1500) <input type="checkbox"/> Activation (RW1200) <input type="checkbox"/> Other _____
14. Work Controls:	15. Protective Clothing:	16. Dosimetry:	17. Checkout Instructions:
<input type="checkbox"/> Facility Support Coverage: <input type="checkbox"/> Intermittent <input type="checkbox"/> Continuous <input type="checkbox"/> Hold Points (See Section 17) <input type="checkbox"/> Air Monitoring <input type="checkbox"/> Shielding <input type="checkbox"/> Other _____ <input checked="" type="checkbox"/> Not Applicable	<input checked="" type="checkbox"/> Gloves (Double) <input type="checkbox"/> Shoe Covers <input checked="" type="checkbox"/> Booties (Outer Rubbers) <input type="checkbox"/> Coveralls <input type="checkbox"/> Red Film Lab Coat <input type="checkbox"/> Respirator <input checked="" type="checkbox"/> Head Cover <input type="checkbox"/> Other _____ <input type="checkbox"/> Not Applicable	<input checked="" type="checkbox"/> TLD <input type="checkbox"/> Self-Reading Dosimeter <input type="checkbox"/> Periodic <input type="checkbox"/> Digital <input type="checkbox"/> Alarming Dosimeter <input type="checkbox"/> Finger Dosimetry <input type="checkbox"/> Not Applicable	<input type="checkbox"/> Whole Body Count <input type="checkbox"/> Urine Sample (Bioassay) <input checked="" type="checkbox"/> Contamination Check <input checked="" type="checkbox"/> Personnel <input type="checkbox"/> Equipment <input type="checkbox"/> Equipment Return <input type="checkbox"/> PCM-1B <input type="checkbox"/> Tools <input type="checkbox"/> Post-Job Survey <input type="checkbox"/> Not Applicable
18. Special Instructions: (Hold Points, special dose limits, etc.): - Use Low Dose Rate Working Area (LDRWA) as much as possible. - Risk all materials leaving the RBA.			
19. Signature Approvals:		Department	Life Number
Signature _____ PS Representative <u>F. S. Representative</u>		Radiological Control	99998
Other (Department Specific)			
20. Close-Out Signature:			
PS Representative			

RADIOLOGICAL SURVEY FORM (FS 1.000.1)		REASON FOR SURVEY		INSTRUMENT																																						
LOCATION / EQUIPMENT: Building 938 Upper Level		<input type="checkbox"/> ROUTINE <input type="checkbox"/> SPECIAL <input checked="" type="checkbox"/> RWP # 938-001		Tennelec																																						
DATE Today		TIME This Morning		Eberline RO-2																																						
<div style="display: flex; justify-content: space-between;"> <div style="width: 70%;"> </div> <div style="width: 25%;"> <p style="text-align: center;">SMEAR SURVEY LOG</p> <p style="text-align: center;"><input type="checkbox"/></p> <p>XXXX Y    XXXX-00 ZZZ    Y- RADIAT Z- READI</p> <p style="text-align: center;">AIRBORN</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th>Sample #</th> <th>Location</th> <th>File Box</th> </tr> </thead> <tbody> <tr> <td>NA</td> <td>NA</td> <td>NA</td> </tr> <tr> <td>NA</td> <td>NA</td> <td>NA</td> </tr> </tbody> </table> <p style="text-align: center;">RADIATIC</p> <p>CONTACT READING 200</p> <p>GENERAL AREA 80</p> <p style="text-align: center;">MASSLINN SL</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td>1</td> <td>&lt;1.000</td> <td>5</td> </tr> <tr> <td>2</td> <td>&lt;1.000</td> <td>6</td> </tr> <tr> <td>3</td> <td>&lt;1.000</td> <td>7</td> </tr> <tr> <td>4</td> <td>&lt;1.000</td> <td>8</td> </tr> </tbody> </table> <p style="text-align: center;">SMEAR SURVEY RESULT</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td>1</td> <td>&lt;1.000</td> <td>7</td> </tr> <tr> <td>2</td> <td>&lt;1.000</td> <td>8</td> </tr> <tr> <td>3</td> <td>&lt;1.000</td> <td>9</td> </tr> <tr> <td>4</td> <td>1.5K</td> <td>10</td> </tr> <tr> <td>5</td> <td>2K</td> <td>11</td> </tr> <tr> <td>6</td> <td>3.5K</td> <td>12</td> </tr> </tbody> </table> </div> </div>				Sample #	Location	File Box	NA	NA	NA	NA	NA	NA	1	<1.000	5	2	<1.000	6	3	<1.000	7	4	<1.000	8	1	<1.000	7	2	<1.000	8	3	<1.000	9	4	1.5K	10	5	2K	11	6	3.5K	12
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Surveyed By: F.S. Technician.
 Reviewed By: F.S. Representative

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